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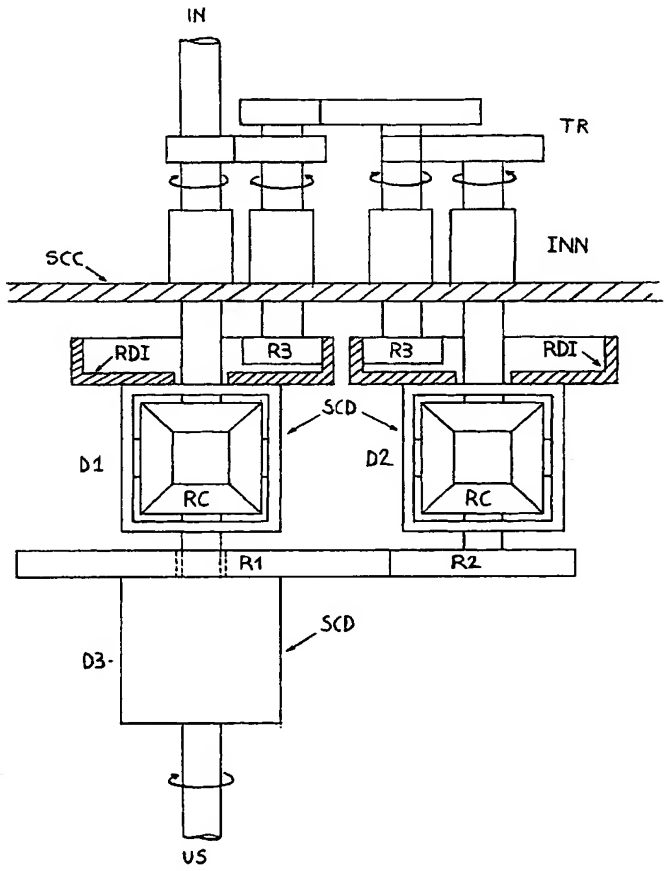
(54) Title: ADDITIVE GEARSHIFT WITH DIFFERENTIAL GEARS



(57) **Abstract:** This invention is a mechanical gearbox for every vehicle or machinery that needs one. It works on the grounds of the differential gear as a way to obtain mechanical addition or subtraction of the motion of two different shafts. Inside this mechanism an input-shaft-motion subdivision take place over other different shafts, which speeds are recombined together by differential gears, returning over an output-shaft a wide-range of selectable speeds with their proportional torque (transmission ratios).

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DESCRIPTION

TITLE: ADDITIVE GEARSHIFT WITH DIFFERENTIAL GEARS

TECHNICAL FIELD: MECHANICS

BACKGROUND ART: Basicly there are 3 main types of gearshifts: manually shifted gearbox with a maximum of about 20 speeds for trucks and 6 for cars; gearbox with planetary gear sets; continuously variable transmission (CVT).

DISCLOSURE OF INVENTION AND BRIEF DESCRIPTION OF DRAWINGS:

INTRODUCTION:

This invention can be catalogued as MECHANICAL GEARBOX, but compared with the usual gear, this one has nearly the CVT's (continuously variable ratio transmission) advantages for its high number of obtainable speeds. The speed-range is very wide (top gears very high and low gears very low), and the gap between them can be very small.

5. This mechanism is extremely versatile and it can be configured in different ways by small variants in the costruction stage. It is possible to obtain: all forward gears; one reverse gear and all restaining forward gears; more reverse gears, or as many reverse gears as forward gears with the same ratios.

9. Every single gear is selectable respecting a definite code to operate the clutches inside the gearbox, and the procedure is fast without the need of a main friction clutch.

The neutral gear is also available.

EXPLANATION:

13. This mechanism is able to output many speed-levels (under the same input). The number of speeds depends on the device complexity due to the quantity of differential gears in it. Examples: 1 differential=3 speeds, 2 differential=7 speeds, 3 differential=15 speeds, 4 differential=31 speeds, and so on. In this application the task of the differential gear is simply to add the speed of two different input shafts rotating in the same direction, and return on a third shaft, the right value of speed with its proportional torque.

19. FIG. 1 illustrates a common differential gear now used to make additions. **A** and **B** are input shafts which rotate in the same direction. The speed of **B** has been reduced by 50% by gears **R1** and **R2**. **R1** is bored out in the center to allow free passage to the input shaft **A**. **R1** is in sympathy with the differential box named **SCD**. Inportant parts are two free-wheels **RL** mounted on both input shafts in order to lock them in the direction opposit to the nominal rotating direction. This in the case one of two input shafts is stationery and there is a load on the output shaft **C**: without free-wheels the stationery input shaft would start rotating in the opposit direction and no torque would come from **C**.

27. The output **C** will be exactly the sum of **A** and **B** but with opposit rotating direction. **RC** are four conical gears. I want to specify that free-wheels will not be mounted on the invenction, it is

just a way to solve the problem.

2. Now we can go on to an overall principle scheme of the gearbox. In FIG. 2 there are four examples showing how it would be possible to connect together 1 to 4 differential gears in order to get 3 to 31 different speed ratios. As we can observe in the plan, the second inportant part of the mechanism consists in the gear train **TR** put before the differential gears **D**. Input shafts to the differential gears come from **TR** and respectively from left to right, each one rotates at the previous one's half speed. By common consent I named the input shafts to the differential gears with the ratio numbers of their speed on the grounds of the slowest of all. The lowest number is 1 and it is also the lowest speed value inside the mechanism and the minimum increase unit of the final output **US**.

11. For porpouse of explanation, from now on we shall take into account a 3-differential gears and 4-input shafts gearbox only (FIG.2.3), because of its avarage complexity and speeds number.

14. The example of FIG.2.3 shows a 15 speeds gearbox. It provides 15 speeds with ratios from 1 to 15, increasing from speed to speed allways by 1. There are four possible input shafts to the gearbox named **IN**. They must be connected to the gear train **TR**. Supposing to enter into the gearbox with an 80 rpm motor in junction with the input shaft 8, we'll get from the output shaft **US** a speed range from 10 to 150 rpm increasing from speed to speed by 10 rpm. The input shaft at the far right is allways the minimum increase unit (as previously described). At this point, supposing to enter into the gearbox with an 80 rpm motor in junction with that shaft (named 1), we'll get from **US** a speed range from 80 to 1200 rpm, but with an increment of 80 rpm.

23. This invention could never work without clutches, essential to engage any speed, not described yet. As FIG.3.1 shows, now, on every single input shaft between the gear train **TR** and the differential gear **D** there is a clutch named **INN**. Clutches cut or transmit the motion to the differential gears as needed, and combined together they determine every single possible speed. Every single possible combination is assured by a simple table (FIG.3.2), calculated on the grounds of the binary number system. The table shows clutches state according to the speed to be engaged. On the horizontal axis there is every single input shaft; on the vertical axis there are the speed numbers. The black dot indicates motion transmission through the clutch, and the white dot indicates no motion transmission.

32. The clutches in use must be DUAL-ACTION type. It means they must have two different states: the first one is motion transmission; the second one is no motion transmission, but this one must also lock, in both rotating directions, the part of the shaft entering into the differential gear and get it in sympathy with the gearbox named **SCC** (FIG.3.1).

36. Up to now, all has been explained is just a theoretical explanation of the invention. Its practical realization will be different from some points of view due to the absolute necessity to

respect the rotating directions of every single shaft inside the gearbox. It is very important for the right operation of all mechanism.

3. According to the rotating directions of the two input shafts in a differential gear used to make additions (as FIG.1), from the output shaft C we can get an addition or a subtraction. Now if we shape the gearbox combining additions and subtractions, as output we obtain a speed range including reverse gear. It is also possible to obtain many different reverse gears, but the total number of speeds is 15 plus a neutral gear. The obtainable configurations are varius.

8. From now on for porpouse of explanation the 3 differential gears inside the gearbox we are talking about are all addition type ("+" sign in FIG.3.1). Consequently all forward 15 speeds are available.

11. In FIG.4 we can see an overall view of the mechanism as it can work. There are some changes compared with FIG.1 and FIG.3.1: on the gear train **TR** and on both internal gears **RDI** of the differential gears **D1** and **D2**. The reason is simple. In FIG.1 input shafts **A** and **B** rotate in the same direction (obligatory condition to obtain additions). Nevertheless, a 4-shafts gear train as FIG.3.1 inverts the rotating direction from a shaft to another, so we could never obtain two adjoining shafts with the same rotating direction. That is why the internal gear is necessary: like chains or belts, it does not revers the motion.

18. However, using this type of gear it is not possible to obtain a 50% reduction ratio (as FIG.1), between **R3** and **RDI** because of the encumbrance of the shaft going into the differential gear. So we can obtain a one-third reduction ratio, but the difference must be compensated by changing gear train ratios. On **TR** we shall obtain an irregular sequence of different ratios that, if correctly calculated, are equivalent to theoretical ones on FIG.3.1.

23. Gears **R1** and **R2** have 50% reduction ratio. **R1** is in sympathy with the differential box of **D3**, and it is bored out in the center to allow free passage to the shaft coming from **D1**. It is the same about **RDI**. **SCC** is the gearbox that clutches **INN** (not drawn in every detail) are locked to. **SCD** are differential boxes that gears **RDI** and **R1** are in sympathy with. The differential gear **D3** has not been drawn in every detail, but it is exactly identical to **D1** and **D2**. **RC** are 4 conical gears inside each differential box. **US** is the final output shaft, and it rotates at the same direction of the input shaft **IN**.

BEST MODE FOR CARRYING OUT THE INVENTION: Make an agreement with a metal and mechanical works.

INDUSTRIAL APPLICABILITY: All motor vehicles and industrial machineries.

CLAIMS

1) Mechanical gearbox characterized in that it works on the grounds of differential gears utilized to obtain mechanical additions or subtractions of the speed of two or more rotating shafts all coming from one gearbox input shaft only.

2) Mechanical gearbox as CLAIMED IN CLAIM 1 includes the following parts: one gearbox input shaft; one gear train arranged on at least two to a maximum indefinite number of shafts; one DUAL-ACTION type clutch mounted on every single shaft coming from the gear train; one to an indefinite number of differential gears which boxes can be in sympathy either with cylindrical gears or internal gears or other types of gears; one output shaft coming from a differential gear.

3) DUAL-ACTION type clutches must determine two different states as follows:
State one: the two parts constituent a clutch are in sympathy with each-other allowing motion transmission along the shaft on which the clutch is mounted.
State two: the two parts constituent a clutch are not in sympathy with each-other, one of which is in sympathy with the gearbox, causing the complete locking in both rotating directions of one part of the shaft along which the clutch is mounted. Motion in both rotating directions is allowed to the other part of the clutch.

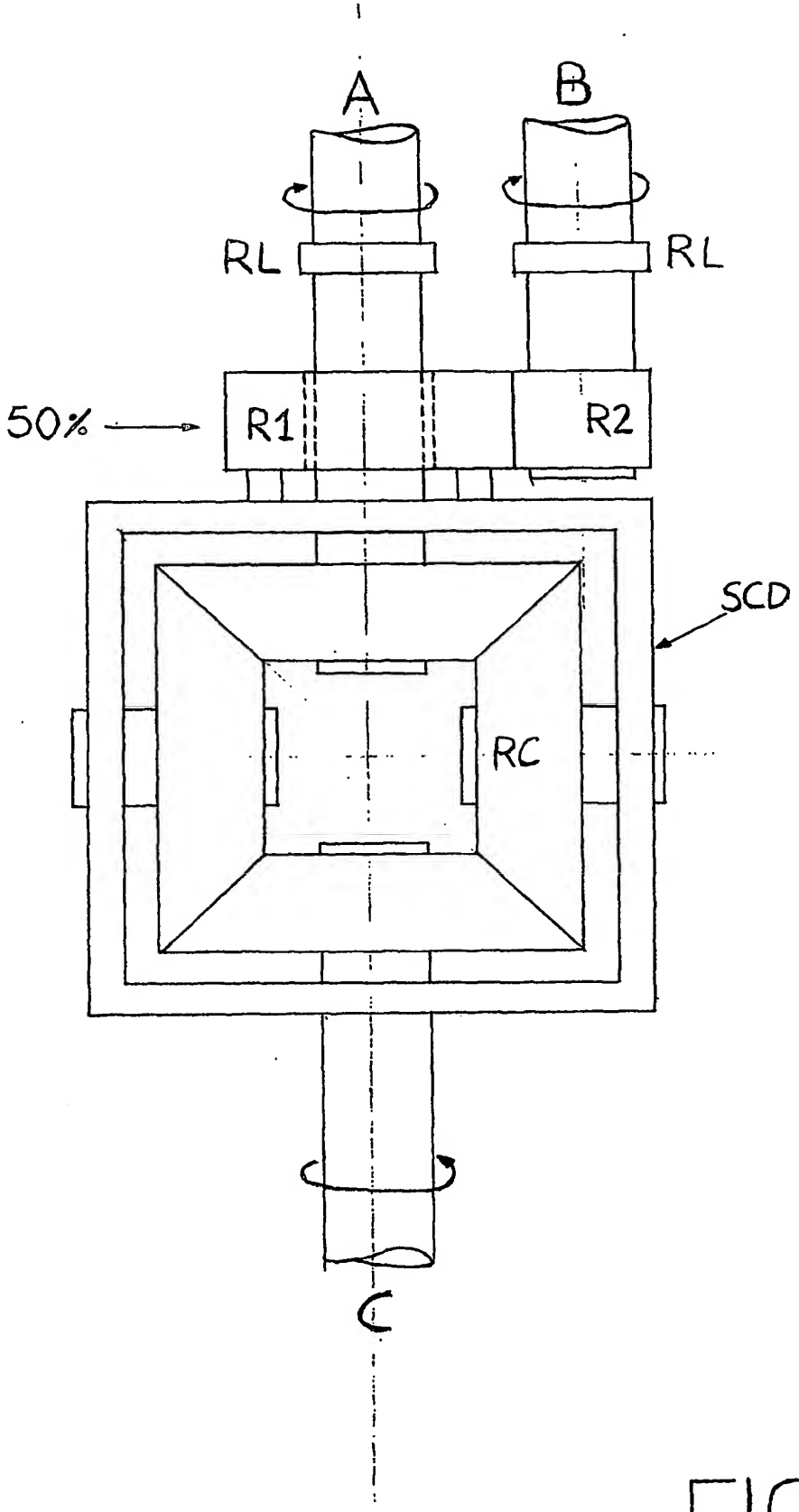

FIG. 1

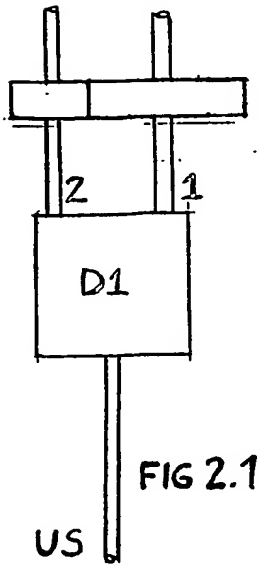

FIG 2.1

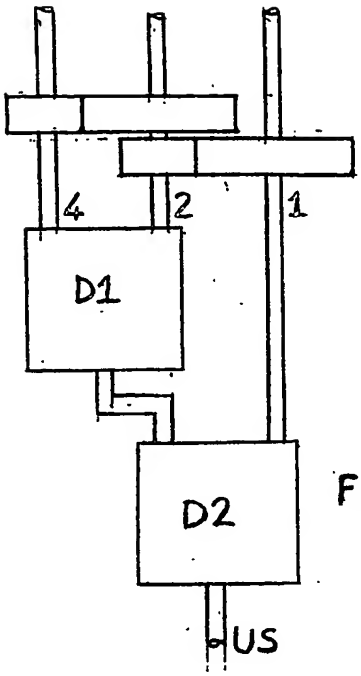

FIG 2.2

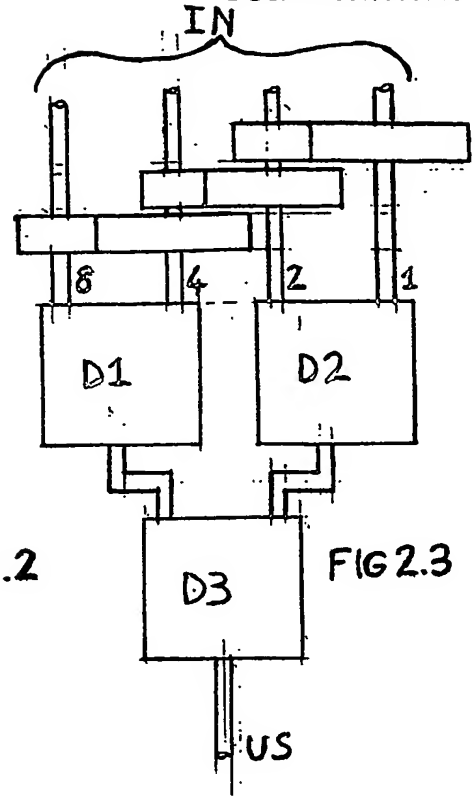

FIG 2.3

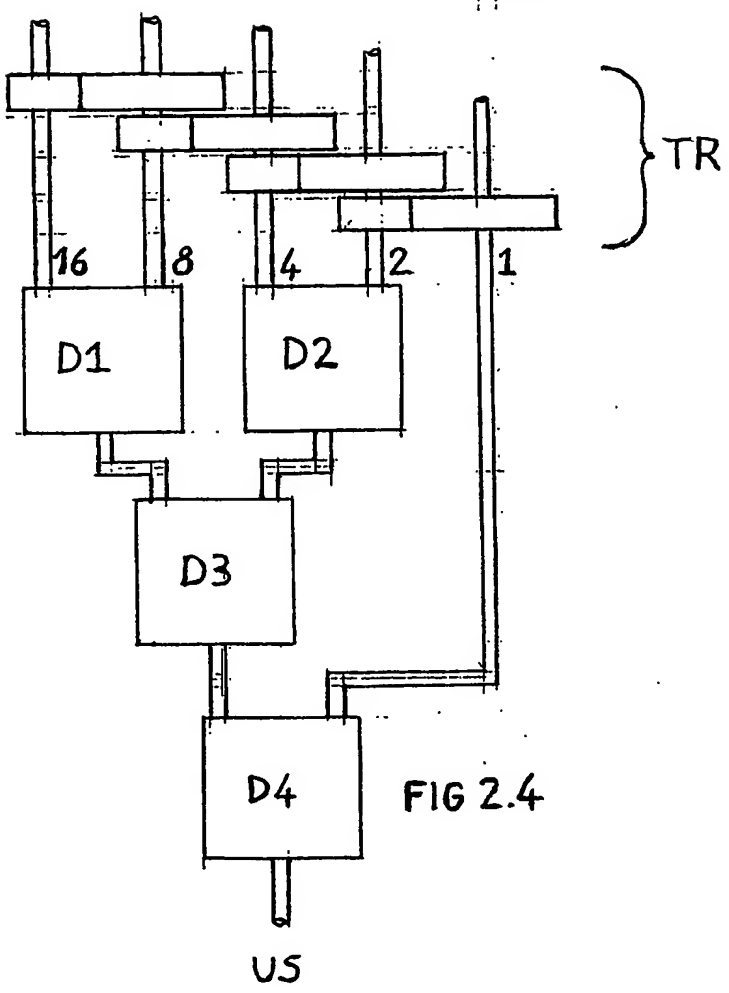

FIG 2.4

FIG. 2

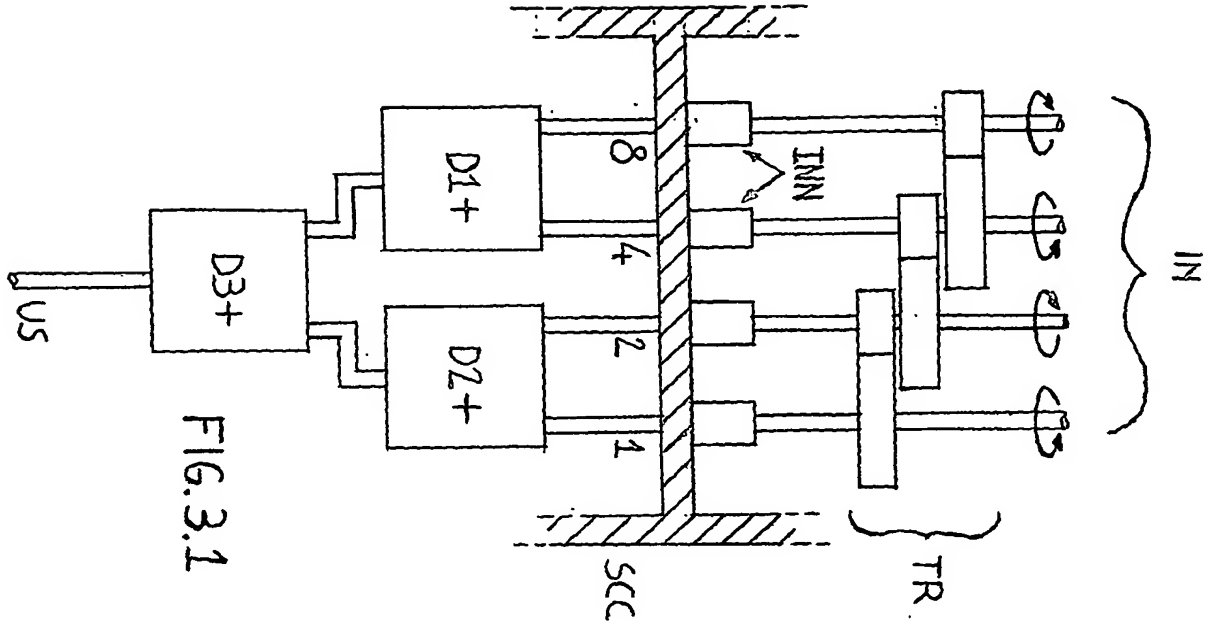

FIG. 3.1

64	32	16	8	4	2	1	
			○	○	○	○	NEUTRAL
			○	○	○	●	1ST
			○	○	●	○	2ND
			○	○	●	●	3RD
			○	●	○	○	4TH
			○	●	○	●	5TH
			○	●	●	○	6TH
			○	●	●	●	7TH
			●	○	○	○	8TH
			●	○	○	●	9TH
			●	○	●	○	10TH
			●	○	●	●	11TH
			●	●	○	○	12TH
			●	●	○	●	13TH
			●	●	●	○	14TH
			●	●	●	●	15TH

FIG. 3.2

FIG. 3

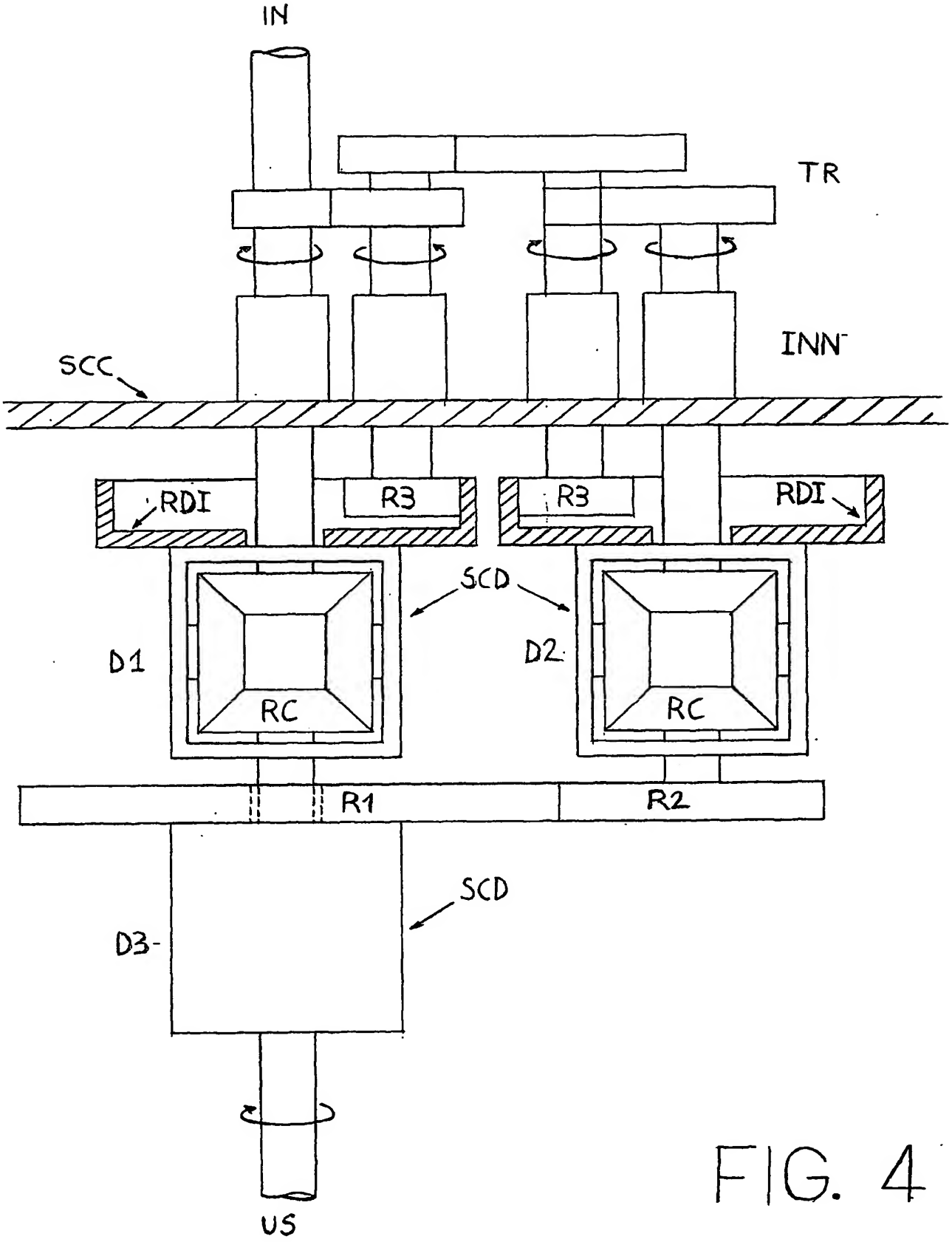

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 03/00373

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16H37/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 259 823 A (CORONEL PAUL K) 9 November 1993 (1993-11-09) column 5, line 37 -column 7, line 10 figures 1,6	1,2
X	FR 2 813 368 A (KAPIKIAN JEAN CLAUDE) 1 March 2002 (2002-03-01) page 4, line 20 -page 6, line 2 figure 1	1,2
X	DE 20 04 694 A (KERN K) 12 August 1971 (1971-08-12) the whole document	1
X	DE 101 38 547 A (HITACHI LTD) 2 October 2002 (2002-10-02) the whole document	3

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search	Date of mailing of the international search report
8 March 2004	14/04/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Hassiotis, V

INTERNATIONAL SEARCH REPORT

Information on patent family members

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